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Analysis of the Internal Combustion Engines Performance Using Biomethane Fuel

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ABSTRACT: *Biogas is an alternative energy source, this energy source is in the form of gas which is dominated by methane gas which can be used as fuel for motor fuels. Biogas is a high pressure fluid. The pressure generated during the combustion process is closely related to the volume of production, if the volume of biogas production is large, the pressure produced by biogas is also high. This study began with biogas purification using coconut shell charcoal as an adsorbent with five variations of the biogas purification flow rate, namely 2, 4, 6, 8, and 10 liters/minute. The results of biogas cleaning will be taken for testing on the performance of internal combustion engines with load variations of 5, 10, 15, 20 and 25 kgf. The results showed that the highest torque was generated on AR10 type biogas fuel with a load of 25 kgf, namely 13,979 Nm. Meanwhile, AR10 type biogas fuel also shows the greatest effective power of 4938.17 Watts at a maximum load of 25 kgf with an average engine speed of 3375 rpm.*

NOMENCLATURE

Symbol	Description	Unit
AR0	Type of biogas before purification	
AR2	Type of purified biogas with a flow rate of 2 liters/minute	
AR4	Type of purified biogas with a flow rate of 4 liters/minute	
AR6	Type of purified biogas with a flow rate of 6 liters/minute	
AR8	Type of purified biogas with a flow rate of 8 liters/minute	
AR10	Type of purified biogas with a flow rate of 10 liters/minute	

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I. INTRODUCTION

Along with the rapid development of industrial technology, the need for renewable energy sources is a very important consideration. This is due to the increasing scarcity of petroleum energy sources and the increasing world price of crude oil, so that innovative research continues to be developed to find renewable energy sources. One alternative energy that is currently being developed is energy derived from organic materials, this is because these organic compounds are classified as renewable energy. The existence of these organic materials is easy to obtain and their continuity is guaranteed, besides that the most important thing is that organic materials are environmentally friendly. Biogas is a product of green technology that is currently being developed. This is because the gas produced from biological processes (anaerobic digester) is capable of producing gases such as CH_4, CO_2, H_2S, H_2O and other gases. Of course, methane gas (CH_4) is used, because CH_4 has a calorific value that can be used as fuel.

Biogas is a renewable energy that is currently being developed as a substitute for petroleum energy sources. In general, biogas itself consists of methane (CH_4) 50% - 70%, carbon dioxide (CO_2) 30% - 40%, hydrogen (H_2) 5% - 10% and other gases in small quantities. The content of CO_2 in biogas is still quite large, in the use of biogas as a new renewable energy, it is necessary to carry out the process of purifying biogas from carbon dioxide gas (CO_2) in biogas.

This biogas purification research used the adsorption method with the adsorbent material used in this study being coconut shell charcoal because it has the potential to reduce the composition of carbon dioxide gas (CO_2) in biogas. In this study, it is expected that the methane (CH_4) gas content in biogas can increase and the CO_2 gas content can be reduced in order to obtain good quality biogas.

Research on H_2S purification in biogas using activated charcoal from mangrove fruit. The results of the study obtained a maximum adsorption capacity of 0.324 mg/gram with an absorption efficiency of H_2S reaching 83.16% at an adsorbent size of 6 ± 8 mesh and a pile height of 8 cm. The equilibrium constant for H_2S adsorption using the Langmuir method was -239.981 and the Freundlich method was 824.89 [1].

The biogas purification process uses 3 adsorbent materials, namely natural zeolite mordenite, 3A synthetic zeolite and Fe_2O_3. The best biogas purification results with natural zeolite activation mode were obtained by activating 5% NaOH, followed by 15% and 0% NaOH. The results of biogas purification using the three adsorbents showed that the adsorption ability of natural zeolite was better than synthetic zeolite and Fe_2O_3 [2].

Purification of biogas using $Ca(OH)_2$ solution, biogas purification was carried out using various absorbent concentrations, namely $Ca(OH)_2$ 0.1, 1.5, and 2.5 M solutions. The gas chromatography test results showed that the gas after being filtered was 100% area, while before purified there is methane gas of 82.46% area [3].

Biogas purification from CO_2 using activated carbon from palm shells compared to commercial activated carbon. The increase in CH_4 levels was 7% and the CO_2 levels decreased by 6.1% using activated carbon from palm shells, while commercial activated carbon increased CH_4 levels by 11.5% and reduced CO_2 levels by 12.9% [4].

In the biogas purification process with a flow rate of 10 l/min which was passed into coconut shell ash, the methane gas content was 40.954% while CO_2 gas was 34.894%. This shows that there was an increase in methane gas levels by an average of 2.62%, while for carbon dioxide gas levels there was also an increase of an average of 3.82% [5].

The results showed that unpurified biogas contained methane gas content of 49.7%. After purification using limestone sediment adsorbent ($Ca(OH)_2$) the highest concentration of methane gas (CH_4) was obtained at a biogas flow rate of 10 liters/minute of 91%. While the concentration of carbon dioxide gas is absorbed perfectly for all variations in biogas flow rate [6].

Testing of combustion engines using purified biogas fuel using pumice paste. The test results show that the best performance of the internal combustion engine at 4500 rpm with a flow rate of 2 liters/minute of biogas purification fuel produces a torque value of 6.98 Nm and an effective power of 3288.09 Watt while the SFCE value is 0.33 Liters/hour.watt [7].

II. RESEARCH METHODS

Equipment used in the study: ½ pk compressor, digester, gas faucet, 110 cc engine, digital balance, pipe cover, 2" pipe, plastic, flowmeter, biogas pump, biogas hose. While the materials used in this study were: water, coconut shell charcoal, EM-4, pipe glue, cow dung. The ratio of mixing cow dung with water is (1: 1) or 500 liters of water with 500 liters of cow dung.

Biogas purification uses five variations of biogas purification flow rates, namely 2, 4, 6, 8, and 10 liters/minute and coconut shell charcoal as an adsorbent. The results of biogas purification will be taken for testing on internal combustion engine with load variations of 5, 10, 15, 20 and 25 kgf.

Prior to the purification process, the biogas in polyethylene plastic is pumped first to flow the biogas into the flow meter by adjusting the flow rate variations according to what was studied, namely 2, 4, 6, 8 and 10 liters/minute and flowed to the coconut shell charcoal adsorbent so that it becomes biogas. which has been purified then immediately accommodated in polyethylene plastic. Each variation of the flow rate has its own plastic container measuring 100 cm x 100 cm before the next testing process is carried out.

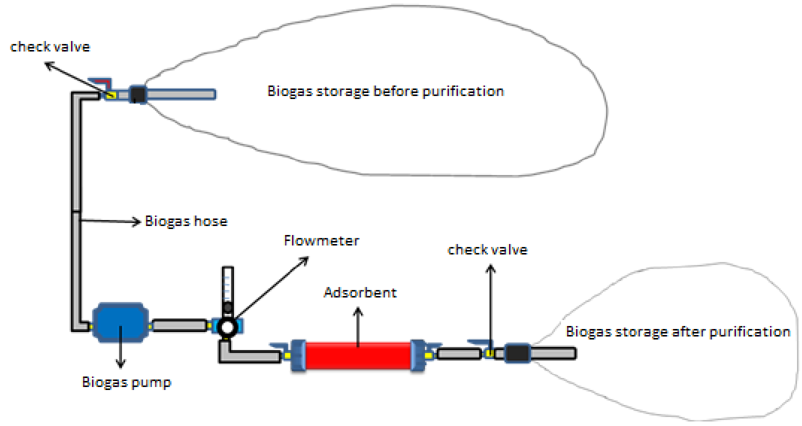

Fig. 1 The process of purifying biogas

The research was continued by testing the biogas before it was purified and after it was purified on a 110 cc internal combustion engine. Tests were carried out with variations in loading of 5, 10, 15, 20 and 25 kgf. Before testing, the engine is heated using gasoline first to normalize the performance of the internal combustion engine, after it feels normal that the flow of gasoline to the engine is closed, then turned on again until the remaining gasoline in the engine runs out, after that the biogas fuel is flowed through the manifold to the combustion chamber. After the engine starts normally, then enter 4th gear, then set the tachometer to 4500 rpm rotation, then hold it down and then load it by pulling the brake lever (or stepping on the brake lever) according to the variation of loading.

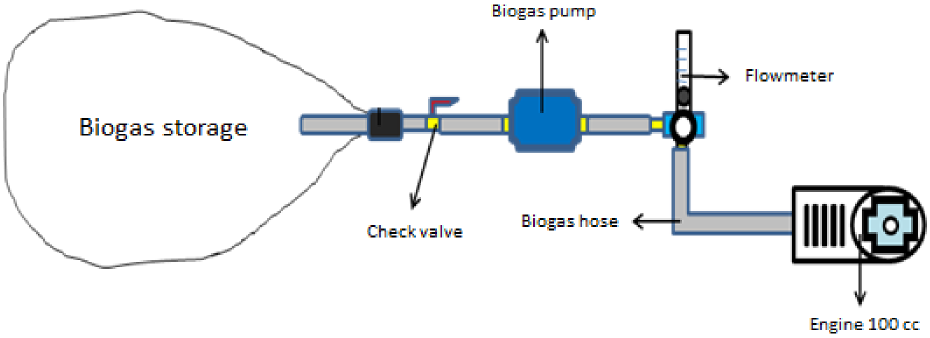

Fig. 2 The testing process on the machine

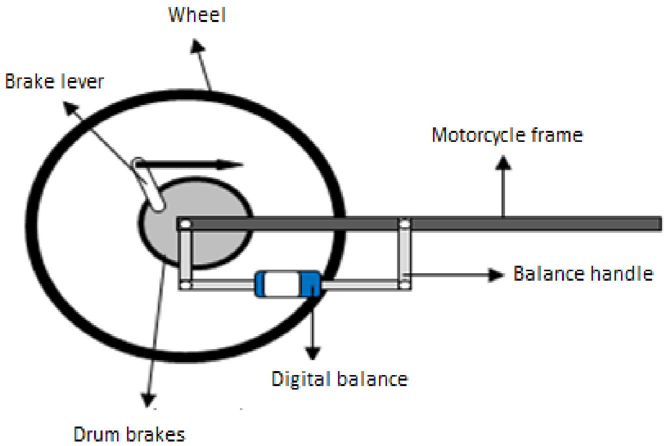

Fig. 3 Loading process on the machine

III. RESULTS AND DISCUSSION

Fig 4 shows that the torque value increases with increasing braking load. The loading values and stationary radii are the same as those used for all types of biogas fuel AR0, AR2, AR4, AR6, AR8 and AR10 (5 – 25 kgf) with stationary radii (0.15 m) so that the torque value is obtained. the same one. Increasing the torque value will certainly affect the effective power that will be produced and in general the highest torque value will certainly result from the highest load, namely at a load of 25 kgf with a torque value of 13.979 Nm.

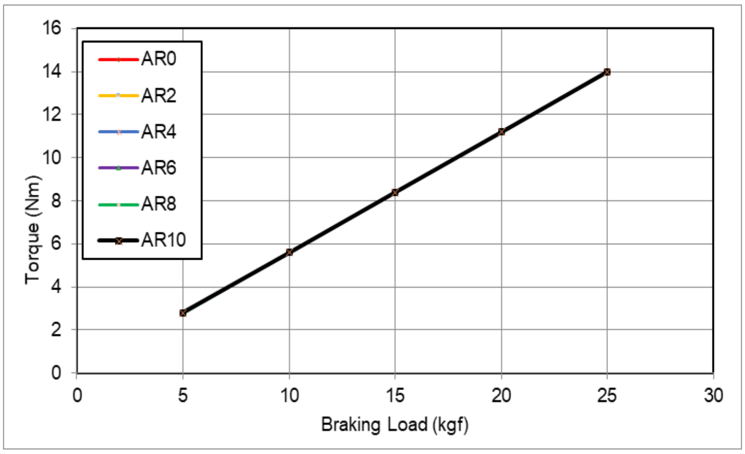

Fig. 4 The relationship between torque and braking load.

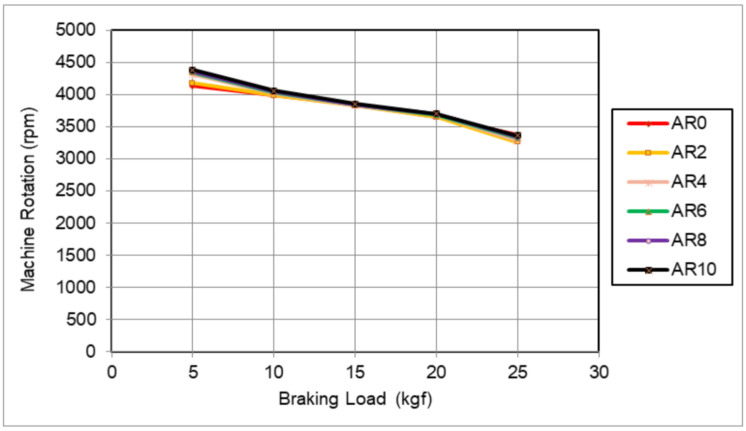

Fig. 5 The relationship between engine speed and braking load

Fig 5 shows that the greater the braking load, the greater the decrease in engine speed. All types of biogas used as fuel experienced a decrease in engine rotation. Fig 5 shows that AR10 type biogas (biogas purification with a flow rate of 10 liters/minute) has the highest rotation after loading compared to other types of biogas, this is because AR10 type biogas has the highest heating value so that a perfect combustion process occurs. this has an impact on high engine speed. Then followed by changes in decreasing engine speed with biogas AR0, AR8, AR6, AR4 and AR2 fuel types.

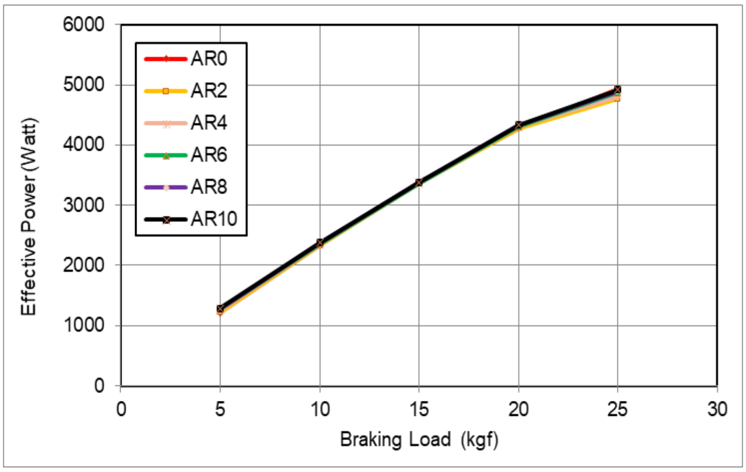

Fig. 6 The relationship between effective power and braking load

Effective power and braking load have a very close relationship, where the magnitude of the loading value will certainly increase the torque value and will affect the value of the effective power. Fig 6 shows that as the braking load increases, the effective power will also increase. AR10 type biogas fuel shows the greatest effective power of 4938.17 Watt at a maximum load of 25 kgf with an average speed of 3375 rpm, this is influenced by the high torque value and the AR10 type biogas has the highest methane gas content so that the process occurs This perfect combustion has an impact on high engine speed which will affect the effective power equation. At the same load (25 kgf) for all types of biogas produce power respectively AR0 (4933.29 Watt), AR2 (4769.91 Watt), AR4 (4808.92 Watt), AR6 (4869.89 Watt), AR8 (4891.84 Watts).

IV. CONCLUSION

The results of biogas purification will be taken for testing on the performance of a 110 cc combustion engine with variations in loads of 5, 10, 15, 20 and 25 kgf. The results showed that the highest torque was generated on AR10 type biogas fuel with a load of 25 kgf, namely 13.979 Nm. Meanwhile, AR10 type biogas fuel also shows the greatest effective power of 4938.17 Watts at a load of 25 kgf with an average engine speed of 3375 rpm.

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